

servation of those familiar with mental disease the responsibility of the individual for acts cannot be doubted. When, therefore, it becomes a question of the responsibility of a person for his acts, a theory is too often misleading.

Judge Ludlow, in his opinion in Taylor's case, has drawn the distinction with the force of scientific truth when he says, Scientific metaphysics, as applied to mind disease, may suggest medical insanity. Whatever medical insanity may be, it is now clearly determined to be the law in Pennsylvania that insanity to be a defence in murder must be determined by legal principles. Responsibility for crime is now to be determined by legal tests. Medical insanity resting on scientific metaphysics may be accepted as authority by medical experts, but before the law, legal insanity can only be recognized.

This enlightened and learned Judge, worn out by judicial labor, ended his days on the 20th day of September, 1886, in the 62d year of his age, with a high reputation, gained and earned in the thirty years of devotion to the conscientious discharge of his high trust.

It is due to the character of James R. Ludlow, that the American Philosophical Society should enroll his name among those of its members who worthily obtained and richly merited by his life-work the honorable distinction of its membership.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF THE
UNIVERSITY OF PENNSYLVANIA.

No. XXIX.

CONTRIBUTIONS TO MINERALOGY.

BY F. A. GENTH.

(With one phototype plate and three wood-cuts.)

(*Read before the American Philosophical Society, March 18th, 1887.*)

I. ON THE OCCURRENCE OF TIN ORES IN MEXICO.

The ores which are the subject of the following investigation were received in January, 1885, from Mr. John L. Kleinschmidt of San Miguel del Mesquital in the State of Zacatecas, Mexico,* to whom I am greatly indebted for this gift, and for highly interesting observations, regarding

* I have just learned from Mr. Kleinschmidt that he has returned to Hillsboro', Jefferson Co., Mo.

their occurrence. They are all from the Sierra de Catatlan, in the State of Durango, and comprise the following :

- No. 1. Ore from Mina del Diablo. "Clace 1^a, Cristal."
- " 2. " " " " " " "Clace 2^a."
- " 3. " " " " " " "de San Antonio."
- " 4. Washings received from Mr. W. Schlemm.
- " 5. Ore from Mina Varosa.
- " 6. Stream tin ore, marked "Superior de Placer."

The central body of the Sierra de Catatlan, in which the mines which have furnished these ores are situated, consists of quartz-porphry, which, in some places, is traversed, in a net-like manner, by small veins of tin ores. About one mile from the Mina del Diablo doleritic rocks occur.

Nos. 1 and 2. The vein of the Mina del Diablo has been traced for about one mile in length, it has a thickness of from eighteen inches to two feet, is almost perpendicular, and perfectly separated from the porphyry by argillaceous selvedges. It consists of a decomposed white clayey material, containing druses of quartz with tin ores. In a pocket was found a white clay in which crystals and crystalline aggregations (No. 1), and also finer ore (No. 2), were intermixed. On washing, this pocket yielded about 54 per cent of clean ore, the crystals and crystalline aggregations were picked out from a large quantity of clay, and weighed about 650 grms, yielding nearly 50 grms in well defined shape.

This occurrence is completely exhausted ; the deeper and harder portions of the vein contain tin ores, but not any of these peculiar crystals. A qualitative examination of the crystals as well as of the finer ores, although different in form, showed the composition of mimetite, mixed with more or less cassiterite, small quantities of porphyry, quartz, hematite, clay, etc. Many interesting specimens of cassiterite, mostly of a red variety, were picked out from the mimetite crystals and crystalline aggregations ; they all showed such an unusual appearance that it was desirable to obtain a larger quantity from the second-class ore. The finer portion was separated by a sieve of 16 meshes to the square inch, and 500 grms. of the siftings treated with hydrochloric acid until all the mimetite was dissolved. The residue was treated with Thoulet's solution, which gave in the heavier portion a little over 15 grams of cassiterite with a few crystals of hematite, while the lighter consisted principally of quartz, with little feldspar, fragments of porphyry, kaoline, etc.

A fuller description and analyses of the various minerals and varieties from the Mina del Diablo will be given in the sequel.

No. 3. The San Antonio Mine has furnished in a seam, six inches in thickness, a length of ten feet, and a height of eight feet, an ore in the form of pulverulent or very friable, earthy yellowish masses, with darker, somewhat more ferruginous streaks. There were only a few very small particles of the red variety of cassiterite present, most of it being of a yellowish color. A partial analysis gave :

SnO ₂	=	31.27
Bi ₂ O ₃	=	6.10
As ₂ O ₃	=	10.13
PbO	=	8.58
Al ₂ O ₃ } Fe ₂ O ₃ }	=	11.39
SiO ₂	=	14.20
Sb ₂ O ₅ , ZnO, MgO, CaO, by diff.	=	12.64
Ignition	=	5.69
		<hr/>
		100.00

A portion of the ore, after washing off the lighter particles and removing the little friable lumps, which showed but a few pseudomorphous crystals of mimetite composition, by a sieve of 16 meshes to the inch, a yellowish sandy powder was obtained, which was analyzed. It was first treated with dilute nitric acid for the determination of chlorine, and then dissolved as far as possible in hydrochloric acid.

The solution contained :

Cl	=	0.070
SiO ₂	=	1.235
P ₂ O ₅	=	0.075
As ₂ O ₅	=	14.290
Sb ₂ O ₅	=	0.263
SnO ₂	=	3.860
Bi ₂ O ₃	=	5.190
CuO	=	0.195
PbO	=	9.482
ZnO	=	3.940
Fe ₂ O ₃	=	4.955
Al ₂ O ₃	=	7.630
MgO	=	0.200
CaO	=	2.120
		<hr/>
		= 53.505

The insoluble contained :

Quartz	=	10.640		
SuO ₂	=	19.300	=	0.129 = 16
As ₂ O ₅	=	1.844	=	0.008 = 1
Sb ₂ O ₅	=	1.040		
PbO	=	0.198		
Fe ₂ O ₃	=	2.945		
Al ₂ O ₃ with traces of ZnO, Bi ₂ O ₃ , MgO, CaO	=	3.208	=	39.175
Ignition	=	7.320	=	7.320
		<hr/>		<hr/>
				100.00

The ores from both mines are melted together with other tin ores, and yield a crude metal, which, after some purification, furnishes a tin, very

well adapted for soldering, notwithstanding the considerable quantities of lead and arsenic which it contains.

No. 4. The washings from the Catatlan mountains, which Mr. Kleinschmidt received from Mr. W. Schlemm, are highly interesting. They consist of a fine sand, the particles rarely over 1^{mm} in size.

There were no lead ores present, but cassiterite, mostly in the red variety, but also minute quantities of the yellow, interesting forms of hematite and alterations of the same, a few crystals of topaz, many minute crystals of durangite, quartz, etc.

No. 5. The ores from Mina Varosa are exclusively of the yellow variety.

No. 6. The Placer ores are both of the red and yellow varieties, the former largely predominating, also pieces showing bands of the yellow alternating with a brown variety.

For comparison several other varieties of Mexican cassiterite were examined which were kindly presented by Messrs. Clarence S. Bement, Joseph Wharton, Prof. Carlos F. de Landero, and Dr. Joseph Leidy, to all of whom I am greatly indebted for their liberality; I am also under great obligations to Professors Gerhard vom Rath and George A. Koenig, for generous aid rendered in the preparation of this paper.

1. *Cassiterite.*

As already indicated, cassiterite occurs in Mexico principally in two varieties, the most abundant of which has a red color, while the other is yellow.

a. Red variety.—Occurs in various shades of red, from bright hyacinth red, brick-red to brownish red, to brown and brownish-black. The powder is from pale to brownish brick-red. The general appearance of the red cassiterite proves that the dioxide of tin was in solution from which it has been deposited upon whatever substances it came in contact with, so that numerous imitative shapes were produced. Thus, we find it as incrustations in plate-like masses which formed upon quartz or porphyry, or in reniform, mammillary, or botryoidal aggregations, frequently in perfect stalactites, which are sometimes not over 0.5^{mm} in length, often hollow, radiating from the centre, often in forms resembling sponges, roots, clubs, &c.; sometimes granular and compact, especially larger masses, which closely resemble compact hematite, towards the exterior frequently assuming a fibrous structure which may end in distinguishable crystals. The outside of the stalactites is frequently covered with exceedingly minute crystals which, however, are so small and irregular that their form can only be determined in very few cases without a microscope. Some microscopic groups of crystals obtained from the Ore No. 2 from Mina del Diablo, most of them not over 1^{mm} in size, are composed of an aggregation of apparently hexagonal plates of a bright hyacinth-red color with rounded

edges, some show flat hexagonal prisms, upon quartz or porphyry, a few also are groups of minute hematite crystals, together with those of hyacinth-red cassiterite. The most remarkable and only specimen which is large enough to distinguish its form with the naked eye came from the pseudo-morphs of mimetite composition of the Mina del Diablo.

It is a little group of $7^{\text{mm}} \times 5^{\text{mm}}$ in size, composed of dark hyacinth red crystals. There may be ten or more little crystals present, but only a few are perfect enough to show the form, but even these have somewhat curved faces and are not smooth enough and are too much interrupted to allow of an accurate measurement. They are slightly barrel-shaped, apparently hexagonal prisms with hexagonal pyramid and basal plane; the largest is 3^{mm} high and of about the same diameter.

The specific gravity of the group was found to be = 6.496, which is evidently too low, probably on account of the presence of a nucleus of quartz or porphyry around which the crystals may have formed.

The question presented itself, whether the observed forms were really hexagonal, in which case the dioxide of tin would be dimorphous, or, whether they were resulting from the twinning of tetragonal forms. In order to obtain a conclusive answer, I submitted this group, and also crystalline sands from the washings, received from Mr. Schlemm, to Prof. Gerhard vom Rath, in Bonn.

I am greatly indebted to him for his aid in this matter, which was exceedingly difficult to determine on account of the great minuteness of these crystals, so that only one of so much experience and perseverance as he has could attempt to solve this important question.

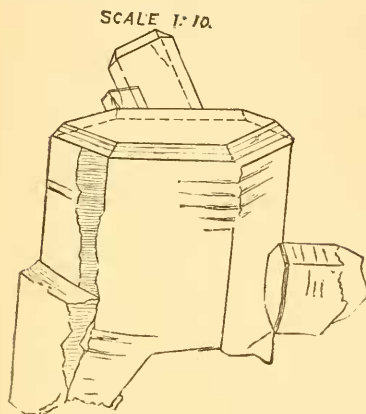
He found nearly 135° for the angle made by the *apparent* basal plane and face of the hexagonal pyramid, which closely corresponds to the angle produced by the first and second tetragonal pyramids of cassiterite. For one prismatic edge he found $112\frac{1}{2}^{\circ}$ (must be 120° in the hexagonal system), and this angle, too, is the ordinary angle of the geniculated edge of cassiterite twins. Furthermore, he was enabled to pick out crystals from Mr. Schlemm's sands, with which approximate measurements of the angles between the basal plane and the six planes of the *apparent* hexagonal pyramid could be made, which gave: $134^{\circ} 10'$, $135^{\circ} 15'$, 135° , 134° , 135° , and $134\frac{1}{2}^{\circ}$, in agreement with the above measurements, as closely as could be expected.

He writes in his last note, under date of October 26th, 1886, referring to the small group of crystals: "You may consider the determination as *quadratic* beyond question, assuming an hexagonal habitus by repeated twinning."

The twin combination resembles figure 162, page 159, in J. D. Dana's "Mineralogy," 1868. I am indebted to Dr. Koenig for the accompanying drawing, illustrating my group of crystals:

Besides the localities mentioned, I have received the red cassiterite from Coneto, in the State of Durango, Comanja and Paso de Sotos, in the

State of Jalisco. Professor G. vom Rath, in his "Geologische Briefe aus Amerika" (Sitzungsberichte der Niederrheinischen Gesellschaft für Natur und Heilkunde in Bonn, July 7th, 1884), mentions it as woodtin, implanted in red porphyry in the Valle San Francisco, San Luis Potosi, also between Sta Rosa and La Fragua, in Guanaxuato, and at Sain Alto and several other localities in the Sierra Zacatecana.



The following analyses of the red variety were made : *

1. Bright brick-red, fine granular, somewhat reniform, the surface assuming slightly fibrous crystalline appearance. Durango ; from my Cabinet, I, a and b.
2. Reniform, curved lamellar, the laminae from 0.1 to 1^{mm} in thickness, separate on breaking with smooth surface slightly granular, brick-red ; powder bright brick red. Coneto, State of Durango ; from Mr. Joseph Wharton, II.
3. Large pebble, somewhat granular, of the appearance of compact hematite, powder brick-red. Durango ; from Mr. Clarence S. Bement, III.
4. A mass which had deposited as an incrustation upon quartz or a siliceous rock, of a thickness of 20^{mm}, with fine crystalline fibrous structure, being flat on the bottom and reniform on the surface. Dark brown, a fresh fracture reddish brown, powder brownish brick-red. Coneto, State of Durango ; from Mr. Joseph Wharton, IV.
5. Stalactitic, granular, the surface covered with minute crystals, color and powder bright brick-red. Minute crystals of hematite were implanted which were separated by a magnet (this hematite being slightly magnetic) ; from the ores No. 1 of Mina del Diablo, V.
6. Botryoidal, dark brown, on fracture paler reddish-brown, with a slightly fibrous structure ; color of powder terra cotta ; from Guanajuato, State of Guanajuato, from Mr. Clarence S. Bement, IV.

* *Artificial Pyrite* —In the analysis it was found to be most convenient to render the cassiterite soluble by fusing with a mixture of sodium carbonate and sulphur, at first at a very low temperature, and then for about ten minutes at low red heat. There was rarely more than a few milligrams of cassiterite left unacted upon which yielded readily to a second fusion. Thus all the tin and arsenic, and the greater part of the iron dissolved in water as sulpho-salts of sodium. In two instances in Analyses III and V b, I was interrupted in my work and the fusion at a low temperature was continued for five or six hours. When the mass was treated with water it dissolved with a yellowish-red color without dark green tint, and the washings also did not indicate that any iron sodium sulphide had gone in solution. The insoluble residue, however, showed the iron in the form of octahedral crystals or clusters of crystals of pale brass-yellow *pyrite*.

	I.		II.	III.	IV.	V.		VI.							
	a	b				a	b								
Sp. Gr.	= 6.829	—	6.594	—	6.911	—	6.535	—	6.714	—	6.712	—	6.581		
SnO ₂	= 92.51	—	92.84	—	93.93	—	93.01	—	92.09	—	86.99	—	86.81	—	92.26
Fe ₂ O ₃	= 4.18	—	4.12	—	5.62	—	5.82	—	5.45	—	11.56	—	12.73	—	4.58
As ₂ O ₅	= trace	—	trace	—	—	—	2.11	—	trace	—	—	—	—	—	1.25
CuO	= —	—	trace	—	—	—	0.07	—	—	—	0.11	—	—	—	trace
ZnO	= —	—	—	—	—	—	—	—	—	—	—	—	—	—	0.57
SiO ₂	= lost	—	2.70	—	0.23	—	1.07	—	0.66	—	0.57	—	0.52	—	0.44
Ignition	= 0.38	—	0.34	—	0.21	—	0.27	—	0.07	—	0.20	—	0.34	—	0.26
			100.00	—	100.07	—	100.21	—	100.38	—	99.43	—	100.40	—	99.36

b. Yellow variety.—It occurs like the red in imitative shapes, and evidently has been formed under similar conditions.

The color is from a pale brownish-yellow, honey yellow to a reddish brown, sometimes greenish-yellow, variegated in bands of paler and darker colors. Globular, reniform, frequently curved lamellar, in many cases the laminae readily separating. Several of the reniform masses from 25 to 35^{mm} in size are really stalactites which have formed upon some unknown irregularly-shaped substance which has weathered out, leaving a cavity, others are flat and have deposited upon quartz, of which some remnants may often be seen. Fibrous, radiating.

The most interesting and apparently purest specimens came from Mina Varosa; it is also associated with the red variety in the Placer ores No. 6, rarely in microscopic botryoidal concretions in the sand from Mr. Schlemm, and also in the ores of the San Antonio mine, forming about one-fifth of the whole mass.

The following analyses have been made:

1. Globular, radiating from the centre; powder cream color. Mina Varosa, State of Durango, VII, a and b.

2. Reniform and lamellar, concentrically fibrous; powder cream color. Mina Varosa, VIII.

3. Flat, brownish-yellow, banded, fibrous, radiating, powder dark cream color; from the Placer ores No. 6, IX.

4. Laminated, reniform, fibrous, brownish-yellow; powder brownish cream color; from Dr. Joseph Leidy, X.

	VII.		VIII.	IX.	X.				
	a	b							
Sp. Gr.	= 6.160	—	6.219	—	6.509	—	6.199	—	6.496
SnO ₂	= 84.20	—	84.30	—	92.50	—	89.90	—	93.13
Fe ₂ O ₃	= 1.31	—	1.55	—	0.22	—	0.10	—	0.20
As ₂ O ₅	= 9.85	—	10.34	—	4.56	—	5.80	—	3.18
CuO	= trace	—	trace	—	0.16	—	0.20	—	0.09
ZnO	= 3.05	—	2.95	—	1.89	—	2.43	—	2.71
SiO ₂	= 0.35	—	0.30	—	0.24	—	0.55	—	0.43
Ignition	= 0.39	—	0.57	—	0.26	—	0.40	—	0.32
	99.15	—	100.02	—	99.83	—	99.38	—	100.06

The analysis of the heavier portion of the ore from the San Antonio mine shows 3.86 per cent of dioxide of tin which went into solution by treating the same with chlorhydric acid. As cassiterite is not acted upon by acids, it is difficult to perceive in which form this tin existed. Dissolving in the presence of a neutral solution of auric chloride gave not a trace of reduced gold, therefore neither tin nor arsenic were in the form of the lower oxides.

There is a sufficient amount of arsenic pentoxide present to combine with all the bases; the lead is evidently in the form of mimetite of which the calculated percentage would be 12.58 per cent, the zinc is probably there as adamite, and the amount of zinc oxide found would give 6.96 per cent of this mineral; no arsenate of bismuth has yet been distinguished as a mineral, but there can be no doubt that the bismuth in the San Antonio ore is present as Bi_2O_3 , As_2O_5 , H_2O , the salt which Salkowski has first described and analyzed (*Journ. für Praktische Chemie*, 104, p. 172), the bismuth oxide found would give 7.94 per cent of the hydrous arsenate.

The insoluble portion of the San Antonio ore contains 19.300 per cent of SnO_2 and 1.844 per cent of arsenic pentoxide. The atomic ratio between these would be = 16 : 1. To this I shall refer again further on.

The different varieties of cassiterite show a considerable variation in their specific gravity which, in part, is probably owing to cavities produced in the process of their formation. The arsenical varieties have all a lower specific gravity.

The analyses show that the red varieties are dioxide of tin, contaminated with ferric oxide, and only exceptionally containing an appreciable quantity of arsenic pentoxide, while the yellow varieties contain very little ferric oxide, but a far higher percentage of arsenic pentoxide and also invariably an admixture of zinc oxide.

It is difficult to perceive how these constituents in such variable quantities could be present in apparently perfectly pure and often highly crystalline minerals.

Excepting analysis V, in which the ferric oxide is double the amount of the average of the other analyses of the red varieties, which may be owing to the fact that the little crystals of hematite which have been observed being only slightly magnetic, were not completely separated by the magnet, they give the atomic ratio between Fe_2O_3 : SnO_2 = 1 : 9 and 1 : 12. Although the ferric oxide cannot be extracted from the stannic oxide by chlorhydric acid, I cannot favor the idea of a definite compound existing between these oxides, and consider them only as mechanical mixtures. The high percentage of arsenic pentoxide, especially in the apparently purest and highly crystalline globular variety from Mina Varosa, and the constant presence of zinc oxide are very surprising. It suggests the idea that there might be a zinc salt of one of the complex inorganic acids consisting of tin dioxide with arsenic pentoxide. A calculation of the molecular ratios of these constituents gave for :

Analysis VII—	As_2O_5	:	SnO_2	:	ZnO	=	1	:	13	:	0.84	
“	of San Antonio ore,					=	1	:	16	:	?	
“	IX—	As_2O_5	:	SnO_2	:	ZnO	=	1	:	24	:	1.2
“	VIII—	“		“		“	=	1	:	31	:	1.1
“	X—	“		“		“	=	1	:	44	:	2.36
“	IV—	“		“		“	=	1	:	68	:	—
“	VI—	“		“		“	=	1	:	123	:	1.4

This shows no rational proportions in the constituents of the cassiterite, and there is no other conclusion than that both arsenic pentoxide, ferric oxide and zinc oxide are admixtures of the tin dioxide, which is easily explained, if we bear in mind the tendency of this latter substance which at the time of its formation, precipitated and retained these oxides.

c. Cassiterite, pseudomorphous after hematite.—It has already been stated that little red crystals of cassiterite are sometimes found associated with those of hematite. From the sands of Mr. Schlemm a few highly interesting, but unfortunately very small specimens were obtained.

One, about 1^{mm} in size, consists of perhaps a dozen modified crystals of hematite, with the basal plane predominating, in which latter twin groups of pseudo-hexagonal red cassiterite are implanted; the occurrence reminds one of rutil which frequently occurs in a similar manner upon the hematite (Eisenrose) from St. Gothard.

Another specimen consists of a group of tabular crystals, radiating from a centre, the whole group 3^{mm} in diameter, which is almost completely altered into reddish-brown brilliant cassiterite, leaving a small core of about 0.5^{mm} in size of unaltered hematite. About ten other pieces of the same kind, although far less perfect, have been observed.

d. Cassiterite, pseudomorphous after magnetite?—A little group of crystals from the ores of the Mina del Diablo—5 × 3^{mm} in size, consists of crystals which are apparently isometric octahedrons, together with some botryoidal aggregations. The crystals are almost black, but mostly show an uneven surface, a color between brownish-yellow and yellowish-green and a waxy lustre, owing to a subsequent coating of reniform, botryoidal cassiterite upon the crystals. A fracture of the crystals shows the dark brownish-red color and lustre of the red cassiterite. The original mineral may have been magnetite. Only three of such minute groups have been found.

Of great interest in connection with these pseudomorphous forms of cassiterite are the observations of Mr. Wm. Semmons (published in London in the December number, 1883, of the Natural History Notes), who describes the coating of bismuthinite (Bi_2S_3) at the Fowey Consols Mine of Cornwall with thin layers of brownish cassiterite. In a letter dated London, August 19th, 1886, Mr. Semmons gives me fuller details about this occurrence as follows:

"The bismuthine (bismuthinite Dana) in this mine is found :

"1. As brilliant untarnished crystals.

"2. Crystals with a slight deposit of cassiterite on them.

"3. With the cassiterite coating the bismuthine in concentric layers, *wood tin*.

"All *wood tin*, the bismuthine having been carried away.

"You doubtless are familiar with the remarkable pseudomorphs of cassiterite after quartz which received for a short time the name of stannite "or silicate of tin from the late John Garby," &c., &c.

I should mention also the very interesting observation of microscopic crystals of cassiterite in the black zinblend of Freiberg, Saxony, described by Dr. A. W. Stelzner, and Dr. A. Schertel (*Jahrbuch für Berg und Hüttenwesen im Königreich Sachsen auf das Jahr, 1886*). The cassiterite in the variety "Nadelzinnerz" occurs associated with quartz crystals and sometimes implanted in the same, in minute and microscopic crystals and groups of crystals. Most of the forms are simple combinations of prisms and pyramids, and have no resemblance with the Mexican specimens. The whole occurrence indicates a simultaneous formation of the zinblend and cassiterite.

2. Hematite.

Both localities, the Mina del Diablo, and that in the Catatlan mountains from which the sands of Mr. Schlemm were obtained, furnished minute, sometimes very perfect, crystals of hematite, occasionally grouped in the form of "eisenrose." The crystals from Mina del Diablo are larger, at times from 2 to 3^{mm} in diameter and have the basal plane oR more fully developed.

The crystals from the sands of Mr. Schlemm are very minute, and I am indebted to Prof. G. vom Rath for the following information :*

Contrary to the general rule these very minute crystals, from 0.25 to 1^{mm} in size show a holohedral development with the second hexagonal prism $\infty P2$, striated parallel to the basal edge, prominent. The second pyramid $\frac{2}{3}P2$ (π in Miller's mineralogy, $\pi : oR = 137^\circ 49'$) dominates the polar development of these crystals. As combinations appear a more acute second pyramid $\frac{4}{3}P2$ (n in Miller, $n : oR = 118^\circ 53'$), R and $-\frac{1}{2}R$. oR appears from a mere point to a relatively large extension. Ironblack, powder brownish-red; slightly magnetic.

As already mentioned under cassiterite, that hematite is sometimes found in part or wholly altered into cassiterite.

* I have sent to Prof. vom Rath the crystals of hematite, above referred to, also the peculiar pseudomorphous crystals with mimetite composition and the first specimens which I had received of the vanadinite and desclowitzite from Oracle, in Arizona. He has taken such an interest in these occurrences that he has communicated the results of his investigations to the "Niederrheinische Gesellschaft für Natur und Heilkunde zu Bonn," at the meeting of January 11th, 1886, which have been published by this Society. In the following pages I shall refer to these communications, as 1. c.



Mimetite Pseudomorphs.

Magnified two diameters.

3. *Mimetite and Pseudomorphs of Mimetite after Anglesite?*

The greater portion of the ores Nos. 1 and 2 from the Mina del Diablo consists of crystals and crystalline aggregations of a white or yellowish-white mineral, rough to the touch, somewhat earthy in appearance, with a slight resinous lustre on a fresh fracture. These crystals have been picked out from a great mass of clay and are a great rarity, and even the crystalline aggregations, which occurred in somewhat larger quantities, are completely exhausted. At the Mina de San Antonio, a few but far less perfect crystals have been observed.

a. Mimetite.—Small fragments of finely granular, frequently cavernous concretions, the surface of which is coated with microscopic colorless crystals, have been found among the above mentioned ores Nos. 1 and 2. Similar crystalline coatings are sometimes observed upon the crystals, especially when in groups, which were better protected against corroding influences, and it is most likely that the whole mass of the pseudomorphous crystals consists of an accumulation of such microscopic crystals, so small, however, that a fracture would show only a compact mineral with a slightly waxy lustre. Cavities of the pseudomorphous crystals are also sometimes lined with colorless microscopic crystals. It was very difficult to observe any distinct forms; when magnified 60 diameters many hexagonal planes were seen, but only one crystal was observed which showed a short hexagonal prism, with a second hexagonal prism, a pyramid and basal plane. Several others were found of the same form without the second hexagonal prism. These crystals have a vitreous lustre and are undoubtedly *mimetite*.

b. Pseudomorphs of Mimetite after Anglesite?—The great bulk of the ore, however, is entirely different and consists of pseudomorphs which have apparently a rhombic form while their composition is that of *mimetite*. They are associated with stalactitic or botryoidal red cassiterite often in isolated crystals with all planes fully developed, upon it, or in crystalline groups or incrusting the same. The whole occurrence shows the more recent origin of the *mimetite* pseudomorphs.

Isolated crystals are rare, they are often cavernous and generally arranged in reticulated and skeleton-like groups. On a most excellent phototype plate by Mr. Frederick Gutekunst, I have given a few of the forms magnified two diameters which show best this peculiar arrangement: 1a, 2a, and 3a are the reverse of 1, 2, and 3.

Measurements of the best isolated crystals gave angles which suggested the idea that the original mineral was *anglesite*.

I have submitted these crystals and aggregations to Prof. G. vom Rath, who had the kindness to make the following measurements, which, together with his conclusions, he communicated, l. c. On account of roughness and imperfection of the surfaces of the crystals only approximate measurements were possible, which were made with the help of attached glass plates.

Considering the crystals as a combination of a macrodome *d* with a brachydome *o*, the approximately measured angles *d* : *d* in axis *c* = $101^{\circ} 30'$ and $102^{\circ} 30'$ and *o* : *o* in axis *a* = $103^{\circ} 30'$, $104^{\circ} 36'$ and $105^{\circ} 30'$, a form which is very close to that of anglesite, if we compare *d* with $\frac{1}{2} \bar{P}\infty$ ($101^{\circ} 13'$) and *o* with $\bar{P}\infty$ ($104^{\circ} 24'$).

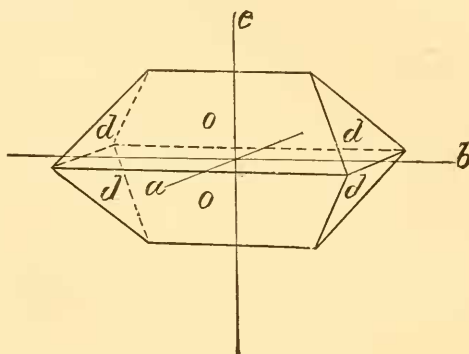


Fig. 9.

Prof. vom Rath is opposed to this view ; he would look upon it favorably if only isolated crystals had been observed, but would consider it very strange to find the skeleton-like formation and the reticulated arrangement of the aggregations in anglesite. He suggests that the primitive mineral might have been reticulated galenite, and he has been supported in this view by the late Prof. Websky, Prof. Descloizeaux and Dr. Hintze. Considering galenite as the primitive mineral, the apparently rhombic forms of these pseudomorphs would be distortions or irregular hemihedries of isometric forms, as it is well known how frequently galenite occurs in forms which have not the habitus of isometric crystals.

However, he was not able to reduce these oblongoctahedrons to normal planes of galenite, and notwithstanding the important opinions sustaining his views, Prof. vom Rath does not feel satisfied and expresses his manifest doubts by suggesting that, these forms might be pseudomorphs after a yet unknown rhombic mineral, having a tendency to occur in skeleton-like aggregations.

I have examined the reticulated galenite specimens in Mr. Clarence S. Bement's magnificent cabinet, but could not satisfy myself that the pseudomorphs under consideration could have resulted from such forms of galenite.

Reticulated galenite is of a rather rare occurrence, and such forms would not be known, if the few localities where it has been found would not furnish it. That anglesite has not been observed in such forms before, does not prove the non-existence of the same.

A suite of these pseudomorphous forms was sent by me to the Imperial

Mineral Cabinet in Vienna, and at my request, to give me his opinion, Dr. Aristides Brezina wrote me under date, Vienna, July 31, 1886 :

“The pseudomorphs are evidently after mendipite* and permit to determine the heretofore incomplete elements of this mineral with a fair approximation :

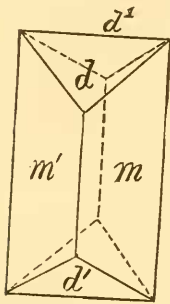


Fig. 10.

$m : m' = 77^\circ 19'$, mean of four measurements with the hand goniometer—mendipite measured $77^\circ 24'$.

$d : d' = 102^\circ 23'$, mean of four measurements with the hand goniometer—

from which it follows that the elements are rhombic.

$a : b : c = 0.8002 : 1 : 0.9948$ ($\frac{a}{c} = 0.8044$) if $m = (110)$;
 $d = (101)$.

“At the same time the pseudotetragonal character is peculiar; the difference of the parameters b and c lies within the errors of observation, but the habitus of the crystals speaks for the rhombic system.”

I thought it best to give these different views, trusting that the future may furnish, by the discovery of the unaltered mineral, together with the pseudomorphs, the true explanation of this doubtful subject.

The analysis of these pseudomorphs shows them to be mimetite in which a small quantity of the lead is substituted by calcium. Even the purest have an admixture of clay, containing a minute quantity of dioxide of tin.

Analyses 1 and 2 were made by myself with material selected from the best crystals and apparently quite pure, 3 and 4 were made by Mr. Harry F. Keller, with apparently pure crystals.

	1	2	3	4
Spec. Grav.	= 6.636	— 6.611	— — —	— — —
Cl	= 2.47	— 2.38	— 2.43	— 2.43
PbO	= 71.40	— 71.27	— 70.63	— 70.56
CaO	= 0.57	— 0.34	— not determined	—
As ₂ O ₅	= 24.97	— 24.58	— 24.82	— 24.57
P ₂ O ₅	= 0.05	— not det'd	— 0.09	— not det'd
Clay with trace of SnO ₂	= 0.65	— 0.85	— 1.44	— 1.89
Ignition	= 0.37	— 0.47	— 0.60	— 0.49
	100.48	— 99.89	— 100.01	— 99.94
Less O, equivalent to Cl	= 0.56	— 0.53	— 0.55	— 0.55
	99.92	— 99.36	— 99.46	— 99.39

* I have just received a letter from Dr. A. Brezina, dated: Wien, April 7, 1887, in which he admits it as an oversight to have considered the mimetite pseudomorphs as being after mendipite, and states that there is now nothing to prevent the acceptance of my original views that the primitive mineral was anglesite.

F. A. GENTH.

University of Pennsylvania, April 20, 1887.

II. VANADINITE AND DESCLOIZITE.

a. Mr. Charles R. Fletcher, of Boston, formerly Superintendent of the Mammoth Gold mine, near Oracle, Pinal county, Arizona, sent me about two years ago a highly interesting and fine variety of vanadinite and descloizite and subsequently, from a new occurrence, he presented me with a number of magnificent specimens of the same minerals, which, as for vanadinite, are some of the finest which I have seen, for all of which I am greatly indebted to him.

Of the first lot received I sent a small piece to Prof. G. vom Rath, who describes it (*l. c.*) as being composed of barrel shaped crystals with a brown nucleus, surrounded by a yellow coating of very fine aggregations of more recent growth, the druses and surfaces covered with exceedingly minute crystals of descloizite.

The vanadinite from this mine occurs upon quartz in crystals, varying in size from 0.1^{mm} to 8^{mm} in length, the smallest crystals are of a yellow color, which changes with their size increasing to an orange yellow, orange red, aurora red to a brownish-red, often variegated. Perfect isolated crystals are rare and generally small, they are mostly united to clusters and crystalline coatings upon the quartz; the crystals are often very much distorted and cavernous. The forms which I have been able to distinguish are the hexagonal prism with pyramid and basal plane, the latter frequently very small or entirely wanting.

Calcite sometimes surrounds the vanadinite and is again covered by vanadinite crystals.

b. A brownish-black and black descloizite from this locality covers in form of a crystalline coating in minute rhombic pyramids the reddish-white massive gold quartz, or is united to clusters of microscopic crystals upon and between the crystallized quartz. Upon these coatings of descloizite are the crystals of vanadinite, which again are covered with exceedingly minute crystals of descloizite. The yellow crystalline coating upon the brown nucleus, mentioned by vom Rath has often *no* nucleus of vanadinite, it is dull and of a yellow color throughout the mass of the hexagonal barrel-shaped crystals. Mr. H. F. Keller, who analyzed the brown and the bright orange red crystals from this locality (a, 1 and 2) found that the yellow mineral contains *no* chlorine. It is very probable therefore that the dull yellow crystals are pseudomorphs of descloizite after vanadinite.

Not enough of the descloizite could be obtained for analysis, qualitative tests however gave lead, zinc and traces of copper and manganese oxides with vanadium pentoxide.

c. A peculiar variety of vanadinite, much resembling pyromorphite, has been noticed in Yavapai county, Arizona, by Mr. J. C. Cooper, of Topeka, Kansas, who has sent specimens to the East. Mr. Clarence S. Bement kindly presented to me one, of which I have made the analysis

given below (c). The crystals occur as a coating upon porous quartz, are barrel shaped prisms with basal plane, from very minute to not over 4^{mm} in size. Their color is from pale green to brownish olive green, small fragments are pale grayish green.

d. Mr. J. C. Cooper presented to me a small fragment of another variety from the same county. The crystals, not over 1^{mm} in size, are of brownish-red color, short hexagonal prisms with basal plane, on some a pyramid is slightly indicated. They cover a dark brown quartz. In some places is a very minute crystalline black coating upon the quartz, which may be descloizite.

e. A very interesting variety of a vanadate, which appears to be vanadinite, has been observed by Mr. J. C. Cooper, at the McGregor mine, Grant county, New Mexico. The specimen, for which I am indebted to him, consists of an impure, friable, earthy hematite, which is coated with crystallized calcite, frequently enveloping stalactites of the vanadium mineral, which is again covered by finely crystalline calcite. After removing the calcite by dilute acetic acid, the orange-yellow and orange-red stalactites remain. They are from 3 to 5^{mm} in length, and up to about 1^{mm} thick. When magnified 60 diameters, they show a core of some other mineral surrounded by scaly crystals of the vanadium mineral, the form of which could not be made out. A qualitative analysis showed lead oxide, vanadium pentoxide, and chlorine as the principal constituents, hence the conclusion that it may be vanadinite.

f. Prof. Albert H. Chester, of Hamilton College, N. Y., presented to me a few fragments of a yellow ferruginous quartz with a pale brownish crystalline coating, which appears to be descloizite, and upon it vanadinite in very minute crystals mixed with larger ones from 5 to 6^{mm} in length, and 0.5 to 1.5^{mm} in thickness, from Bald Mountain mine, Beaverhead Co., Montana. These crystals are hexagonal prisms with basal plane, some slightly barrel shaped, the greater portion of the crystals is of a dark greenish brownish color, their ends capped with almost transparent terminations.

g. In his Re-examination of American minerals, Am. Journ. Sc. [2], xx, 246, J. Lawrence Smith gives a description of vanadate of lead (descloizite?) from the Wheatley mines near Phœnixville, Pa., and an analysis of the same. He had only very impure material, mixed with a large percentage of wulfenite, etc., for examination, so that with the imperfect knowledge which we then (1855) had of descloizite, he expressed his doubt whether it was this species. I have examined a specimen which came from the late Mr. Charles M. Wheatley, at Phœnixville, and have no doubt of the correctness of Dr. Smith's determination.

Analyses of vanadinite. a, 1 and 2 by H. F. Keller ; c by myself.

	a, 1. Brownish. From Mammoth	a, 2. Bright orange-red. Mine.	c. Brownish olive green from Yavapai County.
Sp. grav.	= 6.572	—	7.109
Cl	= 2.41	—	2.69
Fe ₂ O ₃	= 0.48	—	0.04
CuO	= —	—	0.18
PbO	= 77.49	—	77.96
V ₂ O ₅	= 16.98	—	18.64
As ₂ O ₅	= 3.06	—	trace
P ₂ O ₅	= 0.29	—	0.72
	—————	—————	—————
	100.71	101.39	100.23
Less O, equiv. to Cl. =	0.55	0.56	0.61
	—————	—————	—————
	100.16	100.83	99.62

h. Variety of Descloizite, Cuprodescloizite, Ramirite, Tritochorite.—In 1883, Samuel L. Penfield (Am. Journ. Sc. [3] xxvi, 361) published the description and analyses of a mineral from Mexico as a variety of descloizite ; at about the same time, C. Rammelsberg (Berl. Acad., Berl., 1883, 1215), under the name cuprodescloizite gave his analysis and description of the same mineral from San Luis Potosi in Mexico. In a pamphlet, “La Ramirita, nueva especie mineral, Mexico, 1885,” D. Miguel Velasquez de Leon gave the same mineral the name ramirite, with an engraving showing its appearance and an analysis of the same.

In his paper Mr. Penfield referred to the great similarity of the appearance and the results of the analyses of his mineral with those of Frenzel’s tritochorite. About two years ago Prof. F. W. Clarke presented to me a specimen of ramirite from San Luis Potosi, Mexico, and a year ago I had an opportunity to purchase, from Dr. A. E. Foote, a number of pieces which gave such an abundance of very pure material that I thought a re-examination desirable on account of great discrepancies in the amounts of water and the pentoxides of arsenic and vanadium as well as cupric oxide.

The mineral occurs as an incrustation from 1 or 2 to 10^{mm} in thickness, radiating fibrous to fine columnar. The form of the individual crystals cannot be distinguished, they are united into groups resembling the arrangement of cockscomb barite or prehnite. The color is dark yellowish-brown, and the surface has a dark color, and a velvety appearance ; the fracture has a resinous lustre. Powder pale yellow. The spec. grav. = 6.203.

The analyses gave :

	1	2	3	Mean.	Ratio.	
Ignition	= 2.59	— 2.65	— 2.62	— 2.62	0.146	
PbO	= 54.89	— 54.35	— 54.31	— 54.52	0.244	
CuO	= 6.34	— 6.78	— 6.63	— 6.58	0.083	} 0.240
ZnO	= 12.70	— 12.84	— 12.56	— 12.70	0.157	
As ₂ O ₅	= 3.63	— 3.57	— 3.70	— 3.63	0.016	
V ₂ O ₅	= 19.77	— 19.75	— 20.45	— 19.99	0.110	} 0.125
P ₂ O ₅	= 0.13	— not determined	—	— 0.13	0.001	
	—————			—————		
	100.05			100.17		

For comparison I give the mean result of three analyses of Penfield, Rammelsberg's analysis of cuprodescloizite, Velasquez de Leon's analysis of ramirite and Frenzel's analysis of tritochorite.

	Genth.	Penfield.	Rammelsberg.	V. de Leon.	Frenzel.
H ₂ O	= 2.62	— 2.70	— 2.52	—	—
PbO	= 54.52	— 54.93	— 54.57	— 54.275	— 53.90
CuO	= 6.58	— 6.74	— 8.26	— 8.690	— 7.04
ZnO	= 12.70	— 12.24	— 12.75	— 11.250	— 11.06
As ₂ O ₅	= 3.63	— 3.82	— 0.28	— 3.610	— 3.76
V ₂ O ₅	= 19.99	— 18.95	— 22.47	— 19.850	— 24.41
P ₂ O ₅	= 0.13	— 0.18	— 0.17	— 1.830	—
FeO	=	— 0.06	—	Mn ₂ O ₃ = 0.150	—
	—————				
	100.17	— 99.62	— 101.02	— 99.655	— 100.17

My analyses agree very closely with those of Mr. Penfield and give exactly the formula of descloizite $Pb_2 [HO] (VAsP)O_4 + (ZnCu)_2 [HO] (VAsP)O_4$.

In Rammelsberg's analysis the greater portion of arsenic pentoxide has evidently been weighed with the vanadium pentoxide.

In De Leon's analysis the determination of water is omitted, while otherwise the results agree with ours although the copper oxide is about two per cent higher.

The physical characters of the mineral and some of the determinations of the tritochorite agree so closely to cuprodescloizite that it would be desirable if Dr. Frenzel would repeat his analysis.

III. PYRITE PSEUDOMORPHOUS AFTER PYRRHOTITE.

In a highly interesting and important paper on "Natural solutions of gold, cinnabar and associated sulphides, by Geo. F. Becker" (Am. Jour. Sciences [3] xxxiii, p. 199 ff), the author shows the solubility of gold, cinnabar, pyrite and other sulphides in alkaline solutions containing sulphates, and suggests that these minerals, found at Steamboat Springs and Sulphur Bank and similar occurrences, have been deposited from such solutions.

Several months before this paper appeared, Mr. John F. Blandy sent me from the mines near Sulphur creek, Colusa county, California, a number of specimens, containing gold in minute arborescent crystals, and crystalline coatings upon quartz and chalcedony in a dark gray shale from the mines at that locality, also cinnabar and pyrite, which evidently have been deposited under similar circumstances as those mentioned by Mr. Becker.

The pyrite is remarkable. It occurs in the same dark shale as the gold and appears in tabular hexagonal crystals, rarely reaching 1^{mm} in diameter. A few isolated crystals are very perfect, mostly however they are grouped together or one upon the other. Their color is pale brass yellow, they show very little lustre upon the basal plane, which is rather rough, but bright metallic lustre upon the prismatic planes.

A qualitative analysis showed them to be pyrite in composition, the form is that of pyrrhotite, they are therefore pyrite, pseudomorphous after pyrrhotite.

IV. HESSITE.

An interesting variety of hessite has been found at the West Side mine, Tombstone, Cochise county, Arizona, and I am indebted to Mr. Samuel W. Cheyney for specimens for the same.

It is found in vein-like strings or patches in quartz, associated with cerargyrite in small crystals and crystalline coatings, a bluish green and a siskingreen mineral in too small a quantity for investigation, and minute grains of native gold. Color dark iron black; spec. gr. = 8.359.

Soluble in nitric acid without separation of gold.

In analysis 1, 0.61 p. c.; and in analysis 2, 3.98 p. c. of quartz were deducted, and gave :

		1		2
Ag	=	62.87	—	62.34
Pb	=	0.28	—	0.30
Fe	=	37.34	—	37.05
Se	=	trace	—	trace
		<hr/>		<hr/>
		100.49	—	99.69

It is remarkable that no gold is combined with the tellurium, although metallic gold is associated with this hessite.

V. TAPALPITE.

Prof. Carlos F. de Landero has given an account of the occurrence, the properties and the composition of tapalpite from the Sierra de Tapalpa (Boletin de la "Sociedad de Ingenieros" de Jalisco, Tom. v, Num. 3). From an analysis of it which Prof. C. Rammelsberg had made he came to the conclusion that the composition of this mineral is represented by the formula: $\text{Ag}_2\text{S} \cdot \text{Bi}_2\text{Te}_2$.

This being exceedingly improbable, and a re-examination very desirable, Prof. C. F. de Landero has placed me under great obligations for spe-

cimens of this rare species, which have furnished the material for the following investigation :

It occurs at the San Antonio mine in the mineral district of San Rafael, Sierra de Tapalpa, Sayula Canton, State of Jalisco, Mexico.

It has a finely granular structure and a pale steel-gray color, inclining to lead-gray. Lustre dull metallic; soft.

Associated with pyrite, galenite, quartz and a silicate of aluminum and calcium, and so much intermixed with them that it was impossible to obtain pure material for analysis. The purest that could be selected was free from pyrite, but contained about 7 to 8 per cent of galenite and the same quantity of quartz and silicate. The specific gravity, which was found to be = 6.739, was approximately calculated for the pure mineral, and gave — 7.744.

Portions from two pieces, A and B, apparently equally pure, were analyzed. A by dissolving in nitric acid; B by fusion with sodium carbonate and sulphur—the sulphur in B was determined by fusion with sodium carbonate and nitrate, lixiviation with water and five times repeated evaporation with hydrochloric acid in order to reduce the tellurite to tellurous acid and precipitation of the sulphuric acid by barium chloride. The tellurium was always weighed as tellurous oxide.

The portion A gave :

	1	2	Average.	Ratio.	
Ag	= 38.81	— 38.36	— 38.59	— 0.357	= 3
Pb	= 7.22	— 7.26	— 7.24	—	
Bi	= 24.07	— 25.13	— 25.05	— 0.119	= 1
Cu	= 0.23	— 0.19	— 0.21	—	
Te	= 17.43	— lost	— 17.43	— 0.136	= 1.15
S	= 7.93	— 8.54	— 8.24	—	
S required for 7.24 Pb to form PbS	=		1.12	—	
S in tapalpite			= 7.12	— 0.226	= 1.85

$$\text{Ag} : \text{Bi} : (\text{TeS}) = 0.357 : 0.119 : 0.362 = 3 : 1 : 3$$

$$= \text{Ag}_3 \text{Bi} (\text{STe})_3 \text{ or } 3 \text{Ag}_2 (\text{STe}). \text{Bi}_2 (\text{STe})_3$$

The above average analysis and the atomic ratio of the constituents found give the following percentages :

Ag	= 43.76	—	6 Ag	= 648	= 43.76
Bi	= 28.41	—	2 Bi	= 420	= 28.36
Te	= 19.76	—	2.3 Te	= 294.4	= 19.88
S	= 8.07	—	3.7 S	= 118.4	= 8.00
	<hr/>			<hr/>	<hr/>
	100.00			1480.8	100.00

The portion B gave :

	1	2	3	Average.	Ratio.
Ag	= 39.54	— 39.34	— 39.35	— 39.41	0.365
Pb	= 6.13	— 6.28	— 6.25	— 6.22	
Bi	= 22.00	— 21.43	— 20.97	— 21.37	0.102
Cu	= 0.17	—	—	—	
Te	= lost	— 18.53	— 18.53	— 18.53	0.145
S	= 7.16	—	—	— 7.16	
S required for 6.22 Pb to form PbS				= 0.96	
S in tapalpite				= 6.20	0.194

$$\text{Ag} : \text{Bi} : (\text{TeS}) = 0.365 : 0.102 : 0.339 = 3 : 0.84 : 0.93$$

This ratio makes it probable that the portion B had a slight admixture of telluride of silver.

Deducting galenite, &c., the analysis would give the following percentage :

Ag	=	46.09
Bi	=	24.99
Te	=	21.67
S	=	7.25
		<hr/>
		100.00

Imperfect as these results may be on account of the noticed admixtures, there can be very little doubt that tapalpite is a normal sulpho-telluro-salt of silver and bismuth. Rammelsberg gives no lead in his analysis, and may have had purer material at his disposal ; it is to be hoped that such may be obtained for a subsequent investigation.

VI. ALLANITE.

A variety of allanite, closely resembling that from East Bradford, Chester county, Pa., and like the latter easily decomposed into a brown earthy powder, has been sent to me by Mr. J. A. D. Stephenson, who discovered it several years ago near Statesville, N. C.

The pure has a brownish-black color and a pitchy lustre. Associated with it are small zircons.

Mr. Harry F. Keller has made the following analysis :

Sp. Grav.	=	3.63
SiO ₂	=	31.685
Al ₂ O ₃	=	17.330
Fe ₂ O ₃	=	7.052
Ce ₂ O ₃	}	18.990 { of which about 5 per cent Ce ₂ O ₃ , the rest mostly Di ₂ O ₃ .
Di ₂ O ₃		
La ₂ O ₃		
Y ₂ O ₃	}	1.120
Er ₂ O ₃		
FeO	=	10.110
MnO	=	1.025
CaO	=	10.785